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Question Paper Code : 90863

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Fifth/Sixth Semester

Mechanical Engineering

ME 8593 — DESIGN OF MACHINE ELEMENTS

(Common to : Automobile Engineering/Industrial Engineering/ Mechanical Engineering(Sandwich)/Mechanical and Automation Engineering/Mechatronics Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

(PSG Design Data Book can be permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Specify the steps involved in machine design process.

2. Determine the numbers of R20/4(100, ..., 1000) derived series.

3. A shaft requires to be designed and manufactured with a ductile material. List out the two commonly used theories of failure applied in design of ductile material. Justify your choice for conservative approach towards shaft design.

4. In relation with the Mechanics of Materials approach, how a statically indeterminate structural problems can be solved.

5. What will be shape of yield locus for Two-dimensional and Three-dimensional state of stress of:

   (a) Maximum shear stress theory

   (b) Von-Mises theory.

6. Define the term stress concentration also state whether stress concentration is a material property or not.

7. List out the wide range of materials used in manufacturing springs.

8. What are the functions of a flywheel?

9. Why rolling contact bearings are termed as 'antifriction' bearings.

10. A rolling contact bearing with number 6208 is chosen for assembly of gear box. In relation with the bearing number 6208 provide the physical meaning of the digits from right side end.

PART B — (5 × 13 = 65 marks)

11. (a) A manufacturer is interested in starting a business with five different models of tractors ranging from 7.5 to 75 kW capacities. Specify power capacities of the models. There is an expansion plan to further increase the number of models from five to nine to fulfill the requirement of farmers. Specify the power capacities of the additional models.

Or

(b) A transmission shaft carries a pulley midway between the two bearings. The bending moment at the pulley vanes from 200 N-m to 600 N-m, as the torsional moment in the shaft varies from 70 N-m to 200 N-m. The frequencies of variation of bending and torsional moments are equal to the shaft speed. The shaft is made of FeE 400 material with (Ultimate tensile strength = 540 MPa: Yield strength in tension = 400 MPa). The endurance limit of the shaft is finalized as 200 MPa. Determine the shaft diameter with a factor of safety as 2.

12. (a) A rigid coupling is used to transmit 50 kW power at 300 rpm. There are six bolts. The Outer diameter of the flanges is 200 mm, while the recess diameter is 150 mm The coefficient of friction between the flanges is 0.15. The bolts are made of steel 45C8 with yield strength in tension equivalent to 380 MPa and a factor of safety is 3. Determine the diameter of the bolts.

Or

(b) A solid shaft of diameter d is used in power transmission. Due to modification of the existing transmission system, it is required to replace the solid shaft by a hollow shaft of the same material and are equally strong in torsion. Further, the weight of the hollow shaft per metre length should be half of the solid shaft. Determine the outer diameter of the hollow shaft in terms of d.

13. (a) A wall bracket is attached to the wall by means of four identical bolts, two at A and two at B, as shown in Figure 1. Assuming that the bracket is held against the wall and prevented from ripping about the point C by all four bolts and using an allowable tensile stress in the bolts as 35 MPa, determine the size of the bolts on the basis of maximum principal stress theory.

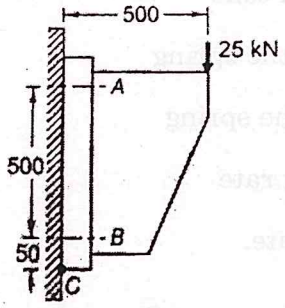

Figure 1

Or

(b) A plate, 75 mm wide and 10 mm thick, is joined with another steel plate by means of single transverse and double parallel fillet welds, as shown in Figure 2. The joint is subjected to a maximum tensile force of 55 kN. The permissible tensile and shear stresses in the weld material are 70 and 50 MPa respectively. Determine the required length of each parallel fillet weld.

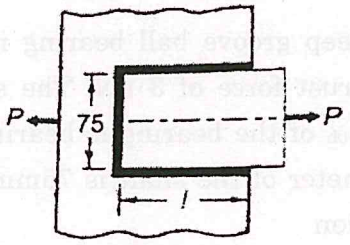

Figure 2

14. (a) A helical compression spring, made of circular wire, is subjected to an axial force, which varies from 2.5 kN to 3.5 kN. Over this range of force, the deflection of the spring should be approximately 5 mm. The spring index can be taken as 5. The spring has square and ground ends. The spring is made of patented and cold-drawn steel wire with ultimate tensile strength of 1050 MPa and modulus of rigidity of 81370 MPa. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate

(i) wire diameter (1)

(ii) mean coil diameter (1)

(iii) number of active coils (1)

(iv) total number of coils (2)

(v) solid length of the spring (2)

(vi) free length of the spring (2)

(vii) required spring rate (2)

(viii) actual spring rate. (2)

Or

(b) The torque developed by an engine is given by the following equation:

$T = 14250 + 2200 \sin 2\theta - 1800 \cos 2\theta$.

where T is the torque in N-m and θ is the crank angle from the inner dead centre position. The resisting torque of the machine is constant throughout the work cycle. The coefficient of speed fluctuation is 0.01. The engine speed is 150 rpm. A solid circular steel disk, 50 mm thick is used as a flywheel. The mass density of steel is 7800 kg/m^3. Calculate the radius of flywheel disk.

15. (a) A single row deep groove ball bearing is subjected to a radial force of 8 kN and a thrust force of 3 kN. The shaft rotates at 1200 rpm. The expected life L_{10h} of the bearing is bearing 20,000 hours. The minimum acceptable diameter of the shaft is 75mm. Select a suitable ball bearing for the application

Or

(b) The following data is given for a 360° hydrodynamic bearing:

Radial load = 3.2 kN

Journal speed = 1490 rpm

Journal diameter = 50 mm

Bearing length = 50 mm

Radial clearance = 0.05 mm

Viscosity of lubricant = 25 cP

Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing, calculate

(i) coefficient of friction (2)

(ii) power lost in friction (2)

(iii) minimum oil film thickness. (3)

(iv) flow requirement in liters per minute and (3)

(v) temperature rise. (3)

PART C — (1 × 15 = 15 marks)

16. (a) A line shaft supporting to pulleys A and B is shown in Figure 3. Power is supplied to the shaft by means of a vertical belt on the Pulley A, which is then transmitted to the pulley B carrying a horizontal belt. The ratio of belt tension on tight and loose sides is 3:1. The limiting value of tension in the belts is 2.7 kN. The shaft is made of plain carbon steel 40C8 with (Ultimate tensile strength = 650 MPa and yield strength in tension = 380 MPa). The pulleys are keyed to the shaft. Determine the diameter of the shaft according to the ASME code if, kb = 1.5 and kt = 1.0.

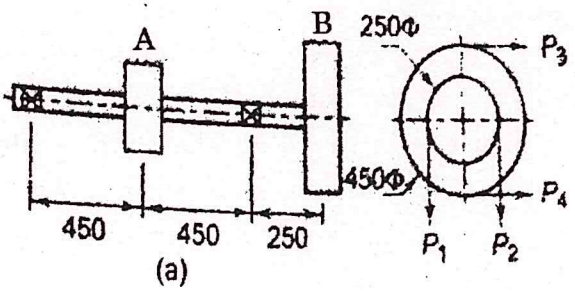

Figure 3

Or

(b) An automotive single-plate clutch, with two pairs of friction surfaces, transmits 300 N-m torque at 1500 rpm. The inner and outer diameters of the friction disk are 170 and 270 mm respectively. The coefficient of friction is 0.35 The normal force on the friction surface is exerted by nine helical compression springs, so that the clutch is always engaged. The clutch is disengaged when the external force further compresses the springs. The spring index is 5 and the number of active coils is 6. The springs are made of patented and cold-drawn steel wires of Grade 2. (G = 81370 MPa). The permissible shear stress for the spring wire is 30% of the ultimate tensile strength. Design the springs and specify their dimensions.